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# A multiplexed electrical impedance-based device for bioengineering applications

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Electrical impedance is one of the most promising technologies used as an indicator for drug response and toxicity testing in cell-based assays, and for monitoring of cellular processes in tissue engineering applications. Bioimpedance-based medical devices have been applied for monitoring the state of tissues and the functioning of organs *in vivo* and *in vitro*.

In the present work the development of a novel, modular, impedance-based biomedical sensor is presented which is designed both for real-time monitoring of cellular dynamics within a 3D porous polymeric scaffold and for *ex vivo* analysis of biological tissues.

The system includes an array of four intelligent bioreactors (Fig. 1a) for parallel analysis where geometrical parameters such as electrode geometry and positioning were optimized by means of finite element (FE) simulations and mathematical analysis. An array of eight needle electrodes are positioned vertically around the periphery of the sample under study. Impedance measurements are carried out using a multiplexed approach where switching between different configurations of current-carrying (CC) and pick-up (PU) electrodes provides a greater positive sensitivity field to the volume of the sample under test (Fig. 1b).

Preliminary results obtained for assessing a 3D culture of cells (HepG2) encapsulated in a gelatin scaffold are shown in Fig. 1c. The growth of cells with time is represented by an increase in the impedance cell index. Variations between different configurations of CC and PU electrodes indicate the variation in spatial distribution of cells within the 3D scaffold. Thus, the bioimpedance-based device presented here has a high potential for real-time monitoring of the entire process of tissue engineering without affecting cell viability.

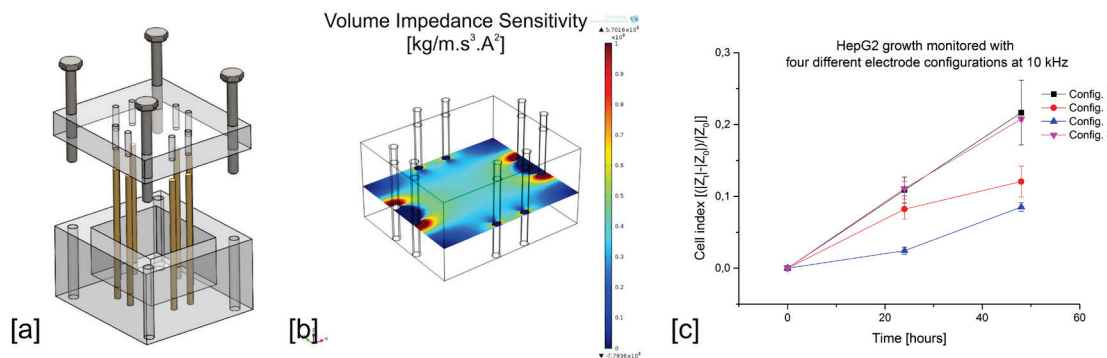


Fig 1: (a) Schematic of a single bioreactor with 8 needle electrodes, (b) FE simulation of sensitivity field using a single electrode configuration, (c) Results showing impedance CI with time for a 3D culture of cells.